

CLAIMS

1. A silicon substrate wherein a depression of a silicon crystal is formed on at least one principal surface side of a crystalline silicon substrate, the silicon substrate having a vitreous region filled in the depression and comprising silicon oxide as a principal component, wherein a glass transition temperature T_g of the vitreous region is lower than a glass transition temperature of pure silica glass and not more than 900°C.
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2. The silicon substrate according to Claim 1, wherein an expansion coefficient α of the vitreous region is greater than a thermal expansion coefficient of pure silica glass.
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3. The silicon substrate according to Claim 1 or 2, wherein an expansion coefficient α of the vitreous region is not more than twice an expansion coefficient of the silicon crystal.
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4. The silicon substrate according to any one of Claims 1 to 3, wherein the vitreous region contains at least one or more out of elements in a group consisting of Group 1a (Li, Na, K, Rb, Ce), Group 2a (Be, Mg, Ca, Sr, Ba), Group 3b (B, Al), Group 5b (P), and Group 7b (F, Cl) in the long-form periodic table.
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5. The silicon substrate according to any one of Claims 1 to 4, wherein the depression of the silicon crystal is formed long in a first direction of the principal surface and relatively short in a second direction, and wherein the vitreous region has a sectional area of not less than $1 \mu\text{m} \times 1 \mu\text{m}$ in a cross section including the second direction and being perpendicular to the principal surface.
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6. A method of forming a silicon substrate, comprising:

a step of forming a mask layer on a front face of at least one principal surface of a crystalline silicon substrate;

a step of removing a part of the mask layer;

5 a step of selectively forming a porous silicon region in the crystalline silicon substrate by anodization in a hydrofluoric acid solution, or through the mask layer in an atmosphere containing hydrofluoric acid;

10 a step of partially or completely oxidizing a silicon fine column inside the porous silicon region to change into a porous region containing silica;

a step of doping the porous region containing silica, with an impurity element;

15 a step of oxidizing and densifying the porous region containing silica; and

15 a step of effecting a temperature decrease according to a predetermined program.

7. The method according to Claim 6, wherein the mask layer is formed using at least one out of amorphous silicon nitride, amorphous silicon carbide, amorphous carbon, and n-type silicon.

20 8. The method according to Claim 6 or 7, wherein the impurity element is at least one or more out of elements in a group consisting of Group 1a (Li, Na, K, Rb, Ce), Group 2a (Be, Mg, Ca, Sr, Ba), Group 3b (B, Al), Group 5b (P), and Group 7b (F, Cl) in the long-form periodic table.

25 9. The method according to any one of Claims 6 to 8, wherein the element as a dopant impurity is introduced in a state of a salt of the

element and an acid radical into the porous region containing silica.

10. The method according to Claim 9, wherein the acid radical of the salt is one selected from a group consisting of halogen elements, nitrate radical, sulfate radical, phosphate radical, carbonate radical, and oxalate radical.

5 11. The method according to Claim 10, wherein the salt is introduced in a dissolved state in a liquid into the porous region containing silica.

10 12. The method according to any one of Claims 6 to 8, wherein the element as a dopant impurity is introduced in a compound state of a metallo-organic compound of the element into the porous region containing silica.